APSW VII

A WORKSHOP ON ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE (ACTS) PROPAGATION STUDIES

ACTS Workshop Opening Remarks

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ACTS propagation data are collected at different sites in North America through NASA's financial support. NASA has two-year contracts with the experimenters. These contracts will expire in late summer 1995. The extension of the ACTS propagation contracts has kept Bob Bauer and myself preoccupied for the last six months. Tasked with an action item in our last workshop (Florida, December 1994), I compiled a letter to NASA Headquarters, see attachment. This letter presents strong arguments for continuing data collection beyond the original two-year period. Bob and I provided data and justification on many occasions to the ACTS program office and Headquarters in the last six months. We have made good progress on this important topic. Bob will discuss the situation this morning.

The data-analysis phase of our campaign has begun. Hardware issues are mostly behind us. Thanks to the engineering support received from David Westenhaver, the terminals are behaving themselves. Mr. Westenhaver will give an update on the health of the ACTS propagation terminals and the associated software.

To the best of my knowledge, all the sites are processing and analyzing data. I was able to receive analyzed data from all the sites for the paper that I wrote for the *International Journal of Satellite Communications.* The only exception was Georgia Tech because this site joined our group only recently. Examples of data received from the sites are given in the following table:

DATA TYPE	SITE
Uplink Power Control	COMSAT
Beacon & Radar Data	Colorado
Scintillation Results	Alaska
Worst Month	Oklahoma
Frequency-Scaling Data	British Colombia
Prediction Model Rain Attenuation	New Mexico
Fade-Duration Data	Florida

The wide scope of the ACTS propagation experiments is evident from the above table. Clearly the next step is to compare our findings with models and use our results to improve those models and develop new ones as required. For these activities, good data calibration is a must, and comparisons should be made correctly. For example, if the 27-GHz channel loses lock, we must account for this anomaly in the statistics when comparing them to the 20-GHz statistics.

Emphasis should be given to industry needs. Several companies are going to use Ka band for their proposed systems: Hughes for SpaceWay, Teledesic, Motorola for Iridium, and TRW for Odyssey. The next set of NASA's TDRS satellites will be equipped with a Ka-band experimental payload, and Milstar uses 20- and 40-GHz

frequencies. Therefore, we seek feedback from industry to ensure that their requirements are addressed in our efforts: data, models, format, etc.

As we get more involved in data analysis, many questions surface. For example, should scintillation be separated from attenuation when calculating fade duration? Or should gaseous attenuation be distinguished from rain attenuation, or . . . Some of these questions can be answered in the plenary session by simply agreeing upon how to do a task. Some can be resolved by receiving feedback from industry. Yet others can be answered by observing what earlier researchers have done. Good sources of information include OPEX reports, Virginia Tech Olympus reports, and the reports of the long-duration experiment at the University of Texas.

To facilitate industry participation, I was asked to prepare a short write-up on our campaign's objectives, structure, and logistics at our meeting in Florida. In response to this action item, I prepared an article that appeared in *The ACTS Propagation Newsletter* last February. To publicize ACTS goals and achievements, our community published many papers and organized conference sessions. All of you have played a role in publicizing ACTS. Please continue doing so. I would particularly like to acknowledge Rudy Henning's efforts in this area. Rudy is always working on a new outreach idea to better inform the user community of our campaign.

To facilitate the dissemination of ACTS data and make our reports easy to read and comprehend, our community is urged to present data in a common format. For example, in the last workshop, it was recommended that cumulative statistics be plotted on the ordinate with attenuation on the abscissa, see Figure 1. Please follow the format of Figure 1 when plotting cumulative statistics. Also note that Figure 1 is the format adopted by the *NASA Propagation Handbook* (NASA Ref. Pub. 1082).

The *ACTS Propagation Newsletter* continues to be published by Kris Suwitra. To publish in this newsletter, please contact her. Kris also maintains the ACTS Propagation Home Page on the World Wide Web (http://www-seg.jpl.nasa.gov/~suwitra/acts.html).

NASA has announced a results conference for ACTS in September (September 11–13). There will be several minisessions on propagation. I would like to invite you to join this conference. By attending, one can become informed of ACTS results beyond our own area.

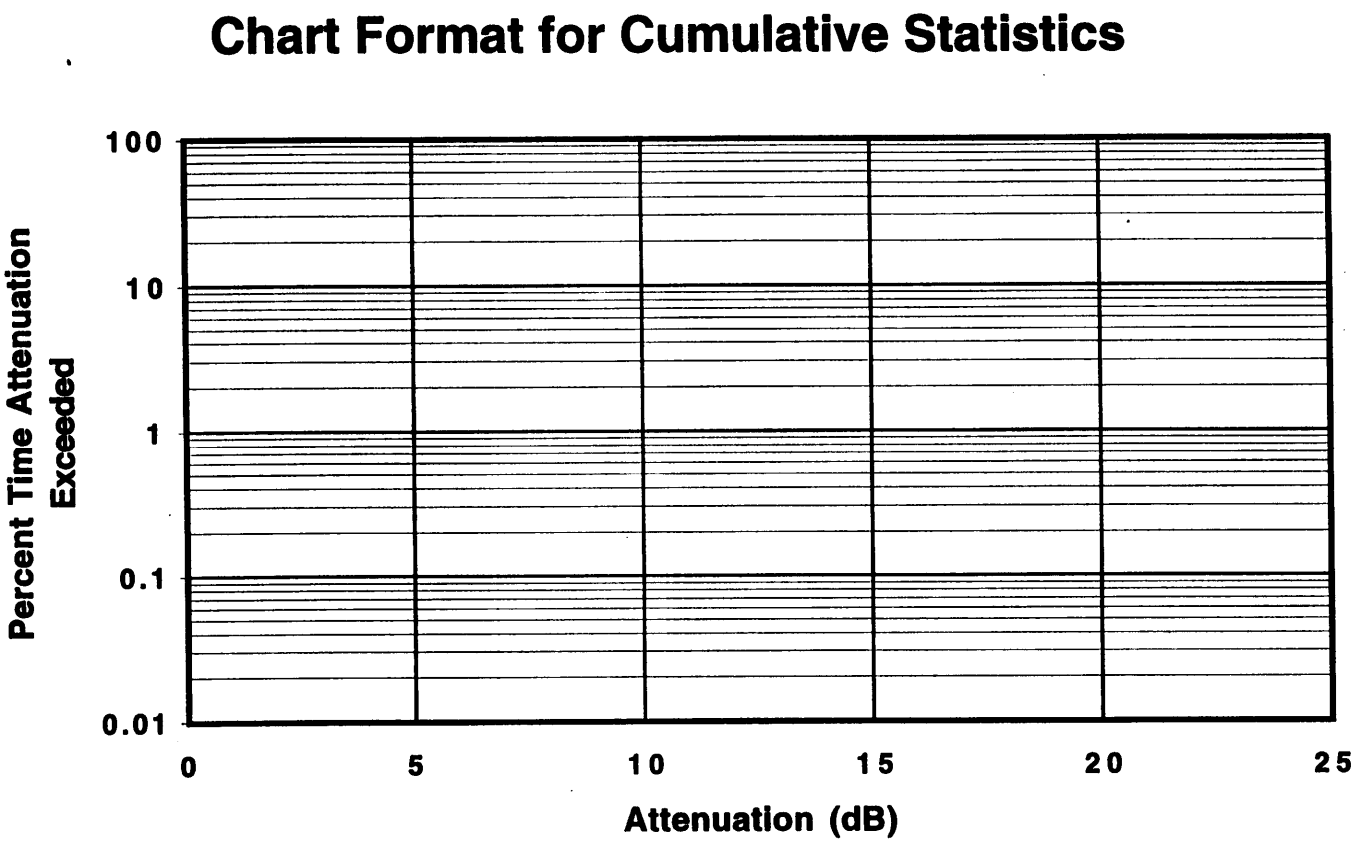

Fig. 1. Common format adopted for ACTS cumulative statistics, with statistics plotted on the ordinate and attenuation on the abscissa.

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Mike Smith
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Dear Mike:

I would like to take this opportunity to report to you on the status of the ACTS propagation campaign. JPL has awarded a contract to David Westenhaver of WWWI for engineering support of the experiment terminals. I am glad to report that ACTS experimenters are now receiving uninterrupted engineering support, and they are most appreciative. Major hardware and software problems have already been addressed, and other issues are currently being worked out in a collaborative effort.

JPL hosted the sixth ACTS Propagation Studies Workshop (APSW VI) at the Florida site of the ACTS propagation measurements, November 29–30, 1994. Attendees consisted of the experimenters and users of propagation data. User participation included such organizations as Hughes, TRW, Stanford Telecom, Teledesic, COMSAT, GTE, Lincoln Lab, E-Systems, and the U.S. Army. These and other users are playing a vital role by helping to define user requirements for ACTS propagation data.

The experimenters reported that they have completed one year of measurements and are beginning the second year of data collection[1]. Due to the deficiencies of the software that had been delivered by the terminal manufacturer, the processed data have not been calibrated properly. Since we had become aware of this problem earlier, with help from Professor Robert Crane of the University of Oklahoma, David Westenhaver had rewritten the preprocessing software and had distributed it a week or two before the workshop. The day after the workshop, on December 1, Professor Crane conducted a hands-on class to familiarize the experimenters with the new preprocessing software. Soon all the experimenters will reprocess their data using the new software to obtain appropriate signal calibration and improved statistical accuracy.

During the workshop, Dr. Wolfhard Vogel of the University of Texas reported that the ACTS Data Center has received nearly one year of raw and preprocessed data from the experimenters. It was noted that due to occasional, but generally infrequent, hardware crashes, segments of data are missing in the first year. However, it is anticipated that hardware-related data loss will be kept to negligible levels during the second year. The ACTS Data Center is a depository for all ACTS raw and preprocessed propagation data. U.S. industry and other users of propagation measurements can conveniently obtain data stored on CD-ROM disks from the ACTS Data Center at the University of Texas.

Plans for 1995 are as follows:

- Process the 1994 raw data using the new software and, as measurements are made, process 1995 data.
- Analyze the 1994 data, and begin the analysis of 1995 data.
- Develop models to predict Ka-band propagation effects on satellite links. These models will reduce the risk of implementing new satellite communication services at Ka-band.
- Begin the dissemination of ACTS propagation results to industry.

It should be noted that, whereas prior measurement campaigns' accuracy was generally poorer than 1 dB, our measurement precision is about 0.5 dB with an RMS measurement error of 0.1 to 0.2 dB. For low-cost, i.e., low margin, satellite systems, this is a very attractive feature of our experiment because for the first time we will be able to separate attenuation by the physical phenomena causing the loss. This can be used to model attenuation at low levels needed for the design of VSAT systems.

[1] The ACTS campaign began its data collection phase December 1, 1993.

A very important subject that was discussed during the workshop was the duration of the ACTS propagation measurements. Both experimenters and users feel strongly that a two-year period is not adequate for establishing sufficient statistics for modeling propagation effects, particularly in light of some missing data during the first year. Here are some of the reasons for their concern:

- If the experiment period is not extended, the goals of the campaign will be compromised. This will have an adverse affect on proposed Ka-band communication systems because the propagation risk factor cannot be appropriately treated in estimates of system reliability. Without an extended campaign period, statistical errors will far exceed measurement errors.
- Because of non-average year climatic conditions, some of the sites showed results which substantially deviated from the norm. This anomaly can only be remedied by multi-year measurements.
- The International Telecommunications Union has requested member administrations for multi-year Ka-band propagation data to assist in the development of system risk models.
- Past theoretical studies and empirical observations have shown weather cycles in the order of about seven years. For this reason, a three- to four-year observation period seems to be the minimum recommendable duration.
- The June 1993 Proceedings of the IEEE published a study on the risks associated with Earth–satellite attenuation prediction. This study concluded that to specify a link budget with a precision of better than 1.5 dB, when the fade margin is 10 dB, more than three prior years of observations are necessary.
- The users present at the workshop felt that, since the ACTS propagation experiments are going to be the last major Ka-band campaign, NASA should see to it that adequate data are collected to enable the development of low-risk applications in this band. This sentiment was especially voiced by industry representatives at the workshop.

It should also be noted that the hardware and logistical expenses associated with initiating the measurement campaign are nonrecurring, and the cost of obtaining additional data with the existing installations is rather modest by comparison.

The workshop concluded with a plenary session, where recommendations were issued and action items were assigned. Bob Bauer and myself were given the task of communicating the needs of our users, i.e., industry, to our NASA sponsor: ***The user community is requesting that the ACTS propagation experiments be extended for at least one more year, with additional time given to experimenters to complete data analysis, i.e., years 1996–1997.***

I might also mention that the experimenters' contracts will end between September and November of 1995, preventing some of the sites from even collecting a complete two-year set of data and not allowing time to analyze all of the collected data. Due to the logistical necessities of the universities, there is a pressing need to inform the contractors of the continuation of the ACTS propagation program by early spring, 1995. This requirement is because of the advanced notice needed to employ or continue the employment of university students.

The proceedings of the APSW VI will be distributed in early January, and you will be receiving a copy.

Best regards,

Dr. Faramaz Davarian
NASA Propagation Program

cc: R. Bauer, R. DePaula, R. Knight, W. Rafferty, R. Schertler